

## Exhibit C-1

The table below lists examples of use of the well-known terms “**bruxer**”, “**bruxers**”, and/or “**bruxism**”, located on the Glidewell Laboratories website at <http://www.glidewelldental.com/>

Exhibit No.	Title/Page	Relevant Excerpt (Emphasis added)	Reference
C-2	Dentist— Services—All- Ceramics— BruxZir® Solid Zirconia	“ <b><u>BruxZir</u></b> , because of its chip-proof durability, <b><u>is</u></b> an ideal solution <b><u>for bruxers who have destroyed their natural teeth</u></b> or existing dental restorations.”	<a href="http://www.glidewelldental.com/dentist/services/all-ceramics-bruxzir.aspx">http://www.glidewelldental.com/dentist/services/all-ceramics-bruxzir.aspx</a>
C-3	FEATURES— BruxZir® Solid Zirconia	<p>“The class-leading strength and durability of <b><u>BruxZir</u></b> restorations make them the ideal restorative solution <b><u>for bruxers</u></b>, implant restorations and areas with limited occlusal space.”</p> <p>“The durability of <b><u>BruxZir</u></b> restorations is ideal <b><u>for bruxers</u></b> who have broken their natural teeth or previous PFM restorations.”</p>	<a href="http://www.glidewelldental.com/bruxzir-zirconia-crowns/features/">http://www.glidewelldental.com/bruxzir-zirconia-crowns/features/</a>
C-4	BRUXZIR FEATURES	<p>“<b><u>BruxZir</u></b> is virtually chip proof, making it the ideal restoration <b><u>for bruxers</u></b>, implant restorations and areas with limited occlusal space.”</p> <p>“The chip proof durability of <b><u>BruxZir</u></b> is ideal <b><u>for bruxers who have broken natural teeth</u></b> or previous PFM restorations.”</p>	<a href="http://www.bruxzir.com/features-bruxzir-zirconia-dental-crown/">http://www.bruxzir.com/features-bruxzir-zirconia-dental-crown/</a>
C-5	Search Results - bruxer	Search results for the term “bruxer” on Glidewell Laboratories yields at least 9 results	<a href="http://www.glidewelldental.com/search/results.aspx?results=bruxer">http://www.glidewelldental.com/search/results.aspx?results=bruxer</a>
C-6	Inclusive Magazine—Mini Implants: An Interview With Dr. Gordon Christensen	“If clinicians attempt to put minis in the mouth of a <b><u>bruxer</u></b> , they’re kidding themselves. I don’t even like conventional-diameter implants in that situation. So, poorly adjusted occlusion or not respecting the fact that he or she is dealing with aggressive occlusion is problematic.”	<a href="http://www.glidewelldental.com/dentist/inclusive/volume2-1/interview-mini-implants.aspx">http://www.glidewelldental.com/dentist/inclusive/volume2-1/interview-mini-implants.aspx</a>
C-7	<b><u>BruxZir®</u></b> Solid Zirconia—	“An esthetic solution for <b><u>bruxers</u></b> when PFM metal occlusal/lingual or full-cast	<a href="http://www.glidewelldental.com/bruxzir-zirconia-crowns/">http://www.glidewelldental.com/bruxzir-zirconia-crowns/</a>

**Exhibit C-1**

	Indications/Contraindications	restorations are not desired or when patient lacks the preparation space for a PFM or has broken a PFM in the past.”	<a href="http://l.com/dentist/services/all-ceramics-bruxzir-tech.aspx">l.com/dentist/services/all-ceramics-bruxzir-tech.aspx</a>
C-8	BruxZir® Blog—More Brawn and Improving Beauty: Anterior BruxZir Crowns	“When we launched <b><u>BruxZir Solid Zirconia crowns &amp; bridges</u></b> in 2009, our intention was to provide a monolithic zirconia restoration indicated <b><u>for bruxers and grinders</u></b> as an esthetic alternative to posterior metal occlusal PFMs and full-cast metal restorations.”	<a href="http://blog.bruxzir.com/">http://blog.bruxzir.com/</a>
C-9	Chairside Magazine—One-On-One Interview of Dr. David Hornbrook	“I mentioned earlier about options in treatment planning: Now I can look at even a <b><u>second molar on a bruxer</u></b> that has decreased vertical dimension and give the patient a restoration that is esthetic, conservative and strong.”	<a href="http://www.glidewelldental.com/dentist/chairside/issues/winter2011/one-on-one-interview.aspx">http://www.glidewelldental.com/dentist/chairside/issues/winter2011/one-on-one-interview.aspx</a>
C-10	BruxZir® Solid Zirconia vs. Ceramco®3 - A Comparative Wear Study	“The wear tests were performed using a pin-on-disk apparatus (chewing simulator, Version 3.1.29, Willytech; Munich, Germany). The <b><u>chewing</u></b> procedure ( <b><u>simulation of bruxism</u></b> ) consisted of $1.2 \times 10^6$ cycles under a load of 50N and a horizontal movement of 0.2 mm (in water).”	<a href="http://www.bruxzir.com/downloads-bruxzir-zirconia-dental-crown/bruxzir-ceramco-comparative-wear-study-0910.pdf">http://www.bruxzir.com/downloads-bruxzir-zirconia-dental-crown/bruxzir-ceramco-comparative-wear-study-0910.pdf</a>

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## BruxZir® Solid Zirconia

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BruxZir® Solid Zirconia is a monolithic zirconia crown, bridge, screw-retained implant crown, inlay or onlay with no porcelain overlay. More brawn than beauty, you'll be impressed by the esthetics of BruxZir when prescribed instead of metal occlusal PFM's and cast gold restorations. BruxZir, because of its chip-proof durability, is an ideal solution for **bruxers** who have destroyed their natural teeth or existing dental restorations.

Designed and milled using CAD/CAM technology, BruxZir is sintered for 6.5 hours at 1,530 degrees Celsius. The final BruxZir Solid Zirconia crown or bridge emerges nearly "bulletproof" and is glazed to a smooth surface. BruxZir Solid Zirconia crowns & bridges are backed by Glidewell Dental Lab's seven-year free replacement warranty.

BruxZir is the fastest-growing product in company history, with dozens of dental labs across the U.S. clamoring to become an Authorized BruxZir Lab. The unique composition of BruxZir has garnered accolades from dental zirconia supplier Tosoh Corporation and in 2011 once again earned a coveted spot on Dentistry Today's Top 100 Products list.

BruxZir is a registered trademark of Glidewell Laboratories.

### PDF DOCUMENTS

[BruxZir vs. Ceramco 3 - A Comparative Wear Study](#)[BruxZir Enamel Wear Test Results](#)[Prep Guide for Metal-Free Restorations](#)

### ADDITIONAL RESOURCES

[Before & After Photos](#)[Case Study](#)[Featured Video](#)[Online CE Course - BruxZir: Virtually Bulletproof — What is it? Why does it work?](#)[Online CE Course - BruxZir Crowns & Bridges Clinical Indications and Scientific Validation](#)[Chairside Magazine: Anterior BruxZir Photo Essay](#)

### EXTERNAL LINKS

[www.BruxZir.com](#)[BruxZir Blog](#)[BruxZir Twitter](#)



## FEATURES

### BruxZir® Solid Zirconia



#### What is BruxZir Solid Zirconia?

BruxZir® Solid Zirconia is a monolithic zirconia restoration with no porcelain overlay. More brawn than beauty, you'll be impressed by the esthetics of BruxZir crowns & bridges when prescribed instead of metal occlusal PFM's and cast gold restorations. The class-leading strength and durability of BruxZir restorations make them the ideal restorative solution for **bruxers**, implant restorations and areas with limited occlusal space.

BruxZir Solid Zirconia is made from the highest quality zirconia powder from Japan. We chemically and physically reprocess the powder to further reduce the zirconia particle sizes. BruxZir milling blanks are then created through a unique patent-pending process. Unlike conventional high-pressure milling blank manufacture, our processing gives BruxZir zirconia improved light transmission, which provides a lower, more natural shade value.

Designed and milled using CAD/CAM technology, BruxZir Solid Zirconia is sintered for 6.5 hours at 1,530 degrees Celsius. The final BruxZir restoration emerges nearly chip-proof and is glazed to a smooth surface.

#### Indications

BruxZir Solid Zirconia is indicated for crowns, bridges, screw-retained implant crowns, inlays and onlays. It is an esthetic alternative to PFM metal occlusal/lingual or full-cast restorations. The durability of BruxZir restorations is ideal for **bruxers** who have broken their natural teeth or previous PFM restorations. BruxZir restorations are also ideal when the patient lacks the preparation space for a PFM.

#### Patient Benefits

- Resistant to chipping because it is made of solid zirconia with no porcelain overlay
- Glazed to a smooth surface to reduce plaque accumulation

#### Preparation Requirements

- Shoulder preparation not needed, feather edge is OK. It is a conservative preparation similar to full-cast gold, so any preparation with at least 0.5 mm of occlusal space is accepted.
- Minimum occlusal reduction of 0.5 mm; 1 mm is ideal.

#### Instructions for Adjustment and Polishing

- Adjust BruxZir restorations using water and air spray to keep the restoration cool and to avoid micro-fractures with a fine grit diamond. If using air only, use the lightest touch possible when making adjustments. A football-shaped bur is the most effective for occlusal and lingual surfaces (on anterior teeth); a tapered bur is the ideal choice for buccal and lingual surfaces.
- Polish BruxZir restorations with the porcelain polishing system of your choice. Or, purchase the Axis Dental BruxZir Adjustment & Polishing Set (LS-7579) through your dental dealer or by calling 800-355-5063.

**IMPORTANT TECHNICAL UPDATE:** Do not use discs to finish full-contour zirconia.

#### Cementation Recommendations

- Resin-reinforced glass ionomer cement (RelyX Luting Cement, 3M ESPE; GC Fuji Plus, GC America)
- Resin cements for short or over-tapered preparations (RelyX Unicem, 3M ESPE; Panavia F2.0, Kuraray)

#### ADA Codes

- D2740 Crown - Porcelain/Ceramic Substrate
- D6245 Pontic Porcelain/Ceramic
- D6740 Abutment Crown Porcelain/Ceramic



**BRUXZIR FEATURES****What is BruxZir?**

BruxZir® Solid Zirconia is a monolithic solid zirconia restoration with no porcelain overlay. More brawn than beauty, you'll be impressed by the esthetics of BruxZir when prescribed instead of posterior metal occlusal PFM's and full-cast metal restorations. BruxZir is virtually chip proof, making it the ideal restoration for **bruxers**, implant restorations and areas with limited occlusal space.

BruxZir Solid Zirconia crowns & bridges are made from the highest quality zirconia powder from Japan. We chemically and physically reprocess the powder to further reduce the zirconia particle sizes. BruxZir milling blanks are then created through a unique patent-pending process. Unlike conventional high-pressure milling blank manufacture, our processing gives BruxZir improved light transmission, which provides a lower, more natural shade value.

Designed and milled using CAD/CAM technology, BruxZir is sintered for 6.5 hours at 1,530 degrees Celsius. The final BruxZir restoration emerges nearly chip proof and is glazed to a smooth surface.



**BruxZir®**  
Solid Zirconia

**Indications**

BruxZir Solid Zirconia is indicated for crowns, bridges, implants, inlays and onlays. It is an esthetic alternative to PFM metal occlusal/lingual or full-cast restorations. The chip proof durability of BruxZir is ideal for **bruxers** who have broken natural teeth or previous PFM restorations. BruxZir is also ideal when the patient lacks the preparation space for a PFM.

**Patient Benefits**

- Chip-resistant, as it is made of solid zirconia with no porcelain overlay
- Glazed to a smooth surface to reduce plaque accumulation

**Preparation Requirements**

- Shoulder preparation not needed, feather edge is okay. It is a conservative preparation similar to full-cast gold, so any preparation with at least 0.5 mm of occlusal space is accepted.
- Minimum occlusal reduction of 0.5 mm; 1 mm is ideal.

**Instructions for Adjustment and Polishing**

- Adjust BruxZir zirconia crowns and bridges using water and air spray to keep the restoration cool and to avoid micro-fractures with a fine grit diamond. If using air only, use the lightest touch possible when making adjustments. A football shaped bur is the most effective for occlusal and lingual surfaces (on anterior teeth); a tapered bur is the ideal choice for buccal and lingual surfaces.
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Technical Update: Do Not Use Discs To Finish Full-Contour Zirconia

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**ADA Codes**

- D2740 Crown - Porcelain/Ceramic Substrate
- D6245 Pontic Porcelain/Ceramic
- D6740 Abutment Crown Porcelain/Ceramic

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### [Zirconia Crown - BruxZir Solid Zirconia Crowns & Bridges - BruxZir ...](#)

BruxZir, because of its chip-proof durability, is an ideal solution for **bruxers** who have destroyed their natural teeth or existing dental restorations. Designed and ...

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### [Dental Zirconia Crown - BruxZir Solid Zirconia Crowns & Bridges ...](#)

An esthetic solution for **bruxers** when PFM metal occlusal/lingual or full-cast restorations are not desired or when patient lacks the preparation space for a PFM ...

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If clinicians attempt to put minis in the mouth of a **bruxer**, they're kidding themselves. I don't even like conventional-diameter implants in that situation. So, poorly ...

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### [Dental Magazine - Chairside Magazine One-on-One with Dr ...](#)

I mentioned earlier about options in treatment planning: Now I can look at even a second molar on a **bruxer** that has decreased vertical dimension and give the ...

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### [Restorative Driven Implant Solutions Vol. 2, Issue 1](#)

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attempt to put minis in the mouth of a **bruxer**, they're kidding themselves. I don't even like conventional-diameter implants in that situation. So, poorly adjusted ...

[www.glidewelldental.com/downloads/dentist/.../Winter2011-v2-1.pdf](http://www.glidewelldental.com/downloads/dentist/.../Winter2011-v2-1.pdf)

### [Porcelain Crown - IPS e.max & IPS Empress - Glidewell Direct ...](#)

IPS e.max should not be used on patients with dysfunctional occlusion such as **bruxers** or clenchers. IPS e.max should not be used as abutments for cast ...

[www.glidewelldental.com/lab/services/emax-empress-tech.aspx](http://www.glidewelldental.com/lab/services/emax-empress-tech.aspx)



### [Dental Zirconia Crown - BruxZir Solid Zirconia Crowns & Bridges ...](#)

Virtually chip-proof, BruxZir Solid Zirconia crowns and bridges are the ideal restoration for **bruxers** and grinders. If you would like to market BruxZir Solid Zirconia ...

[www.glidewelldental.com/lab/services/bruxzir.aspx](http://www.glidewelldental.com/lab/services/bruxzir.aspx)

### [Porcelain Dental Veneers - Vivaneers No-Prep Veneers - Glidewell ...](#)

Patients with dysfunctional occlusion such as **bruxers** or clenchers should be warned that they stand an increased chance of fracture even if the veneers do not ...

[www.glidewelldental.com/lab/services/vivaneers-tech.aspx](http://www.glidewelldental.com/lab/services/vivaneers-tech.aspx)

### [Chairside Magazine, Volume 2, Issue 3](#)

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At recall, the patient's Ribbond splints were intact as she was not a **bruxer**. It is unlikely that this case would have succeeded without fixed retention. ...

[www.glidewelldental.com/downloads/dentist/.../winter2007-2008-v2-3.pdf](http://www.glidewelldental.com/downloads/dentist/.../winter2007-2008-v2-3.pdf)

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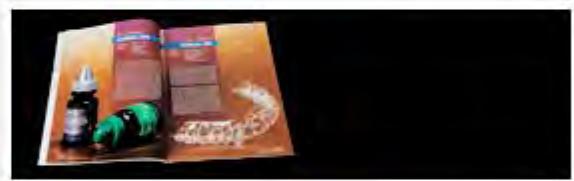
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## BruxZir® Solid Zirconia

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### INDICATIONS / CONTRAINDICATIONS

Indicated for crowns, bridges, implants, inlays and onlays. An esthetic solution for **bruxers** when PFM metal occlusal/lingual or full-cast restorations are not desired or when patient lacks the preparation space for a PFM or has broken a PFM in the past. BruxZir can also be used for anterior teeth with a facial veneer of porcelain for improved esthetics.

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# BruxZir® Blog

## Welcome to the BruxZir Blog

The BruxZir Blog is the source for the latest news about the procedures, techniques and technology related to BruxZir Solid Zirconia. Join in the conversation!

## BruxZir Links

[BruxZir Blog Home](#)  
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## Recent Posts

- [More Brawn and Improving Beauty: Anterior BruxZir Crowns](#)  
Friday, October 28, 2011
- [Glidewell Dental Lab Launches the BruxZir® Milling System](#)  
Thursday, June 09, 2011
- [Technical Update: Improved BruxZir Esthetics Thru Ultrasonic Cleaning](#)

## More Brawn and Improving Beauty: Anterior BruxZir Crowns

When we launched **BruxZir Solid Zirconia** crowns & bridges in 2009, our intention was to provide a monolithic zirconia restoration indicated for **bruxers** and grinders as an esthetic alternative to posterior metal occlusal PFMs and full-cast metal restorations. The result was a material we said was "More Brawn than Beauty."

Now we like to say that BruxZir is "More Brawn and *Improving* Beauty," as our **Research and Development** team continues to refine our processes, improving the esthetics and the strength of the material. We invite you to view our most recent BruxZir Solid Zirconia anterior case below and see for yourself.

The BruxZir crowns were done on tooth #8 and #9.

### Before



As you can see in the non-retracted before photo, the patient had two pre-existing high value PFMs. As I cut through them the copings appeared to be base metal. When you look at the condition of the gingiva in the before photo, was this possibly a base metal allergy? It helped with my decision to go with BruxZir all ceramic (solid zirconia) crowns.

## Calendar

January 2012						
Su	Mo	Tu	We	Th	Fr	Sa
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## Category Archives

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- [Case Studies \(11\)](#)
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- [Practice Management \(5\)](#)
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## Monthly Archives

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  - [October 2011 \(1\)](#)
  - [June 2011 \(1\)](#)
  - [May 2011 \(1\)](#)
  - [April 2011 \(1\)](#)
  - [March 2011 \(1\)](#)
  - [February 2011 \(3\)](#)
- [= 2010](#)

Tuesday, May 31, 2011

Glidewell Laboratories Launches Recycling Program for BruxZir Milling Blanks

Friday, April 22, 2011

Dr. Gordon Christensen on BruxZir® Solid Zirconia

Thursday, March 24, 2011

New Online BruxZir® Solid Zirconia Clinical Video

Wednesday, February 23, 2011

Glidewell Laboratories Announces Nanozirconia Technology Breakthrough

Monday, February 14, 2011

BruxZir Anterior Case

Tuesday, February 01, 2011

Hammer Test: BruxZir® vs PFM

Thursday, December 23, 2010

Technical Update: Do Not Use Discs To Finish Full-Contour Zirconia

Monday, December 20, 2010

#### Tag Cloud

Adjusting Anterior Before and After Benefits Bridge Case

Cementation Crown Development

Enamel Polishing Preparation Press

Release Research Research and Development

Shading Studies Video Wear

Zirconia

with my decision to go with BruxZir all-ceramic (solid zirconia) crowns.

After



Before



After



In the retracted view, you can see the full extent of the gingival tissues. As I placed the topical on tooth #9 with a cotton swab, it started to bleed! You can see that the midline on the existing crown is off, as are the axial inclinations of the two crowns. The unhealthy gingival tissue was removed with a diode laser and BioTemps were placed. I've found the smooth glazed surface of BioTemps helps gingiva heal faster in these type of cases.

Before



After



#### BruxZir Twitter

##### BruxZir

McElvain #Dental Laboratory in Colville, Washington is an Authorized BruxZir Lab!  
<http://t.co/nArzR5cq> #dentistry 5 days ago

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As you view the crowns in the lateral smile view, you will notice the flat facial profiles of these crowns.

Before



After



This is much more difficult to achieve with bi-layered restorations such as porcelain fused to metal or porcelain fused to zirconia. Since a BruxZir zirconia restoration is monolithic (one layer), it is much easier to achieve desirable contours.

A video of this clinical case is also available:

[Replacing PFM Crowns On Teeth 8 & 9 with BruxZir® Solid Zirconia Crowns](#)

Clinical Dentistry by Michael C. DiTolla, DDS, FAGD

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Posted by Glidewell Laboratories at 10/28/2011 7:25 AM | Add Comment

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### Glidewell Dental Lab Launches the BruxZir® Milling System





Glidewell Laboratories, industry-leading provider of [dental lab](#) products and services, announced today the release of its [BruxZir Milling System](#) for the milling of authentic BruxZir® Solid Zirconia. The purpose-built, compact BruxZir Mill is custom built at the lab's California facilities and currently has an approximate order lead time of 10 weeks. Dental laboratories that purchase the BruxZir Milling System will join the growing network of Authorized BruxZir Labs.

The BruxZir Milling System is used to mill crown & bridge restorations or copings and understructures from BruxZir, a [monolithic zirconia material](#) with a fracture toughness measured as high as 1450 MPa. Proven production capabilities include output of a single zirconia coping in as little as five minutes, and a full-contour crown in just nine minutes. An open system designed specifically for use with zirconia, it integrates with 3Shape and other popular dental CAD software. The system runs on four axes, with travel range of 150 mm horizontal (x, y) and 75 mm vertical (z). The spindle speed is 50,000 rpm and includes an automatic four-tool changer. Power requirement is 115VAC/15A, and air requirement is 60 PSI. Machine weight is approximately 480 pounds, with outer dimensions of 29" W x 32" D x 72" H.

Purchase of the complete BruxZir Milling System comes with on-site installation and training, as well as production backup via outsource milling support in the event of a service outage. A step-by-step training DVD demonstrating the BruxZir restoration manufacturing process is also included with purchase of the unit.

Dental Laboratories that purchase the BruxZir Milling System will be added to the growing network of Authorized BruxZir Labs. As an Authorized BruxZir Laboratory, the lab gains exposure through national brand marketing of BruxZir. To learn more about BruxZir and to see a full list of [Authorized BruxZir Labs](#), visit [www.bruxzir.com](http://www.bruxzir.com). For pricing, more information or to place an order, call Glidewell Direct at 888-303-3975.

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Posted by Glidewell Laboratories at 6/9/2011 7:32 AM | Add Comment

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[Technical Update: Improved BruxZir Esthetics Thru Ultrasonic](#)

### Cleaning

With the ever-increasing demand for BruxZir Solid Zirconia, **GlideWell Laboratories** has continued to devise, test, and implement new processes intended to improve both the quality of these crown & bridge restorations and the efficiency with which they are produced. Often, an innovation in one area provides enhanced results in the other. One such innovation is the new process by which GlideWell technicians clean milled BruxZir restorations and prepare them for coloring.

[Click here to read the Technical Update: Improved BruxZir Esthetics Thru Ultrasonic Cleaning](#)

The new method involves the use of an ultrasonic bath to clean the milled block, which is faster, cleaner, and more effective than brushing each crown by hand. Crowns are then cut from the block, grouped by their designated shade, and bathed again, helping to remove all of the fine particles from the crown surface. The shade-grouped crowns are then placed in sintering trays and dried — first in a microwave and then beneath a heat lamp. Once dried, the crowns are submerged in the proper coloring solution and colored under vacuum, after which they are dried again before being sintered.

Scanning Electron Microscopic analysis of zirconia dust:

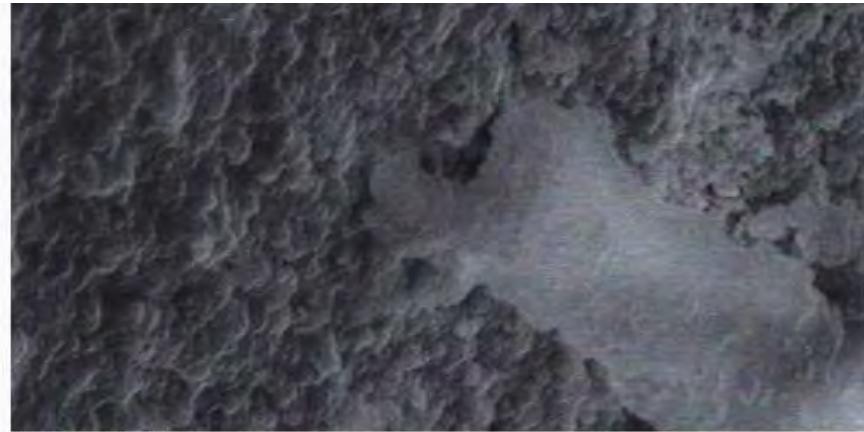
#### As-Milled



SEM 5000x

#### After Brushing





*After Ultrasonic*



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Posted by Glidewell Laboratories at 5/31/2011 3:07 PM | Add Comment

## Glidewell Laboratories Launches Recycling Program for BruxZir Milling Blanks



Glidewell Laboratories, industry-leading provider of [dental lab](#) products and services, announced today its newest green initiative: the recycling of post-milled [BruxZir Solid Zirconia Milling Blanks](#).

The Glidewell Laboratories Research & Development team, using innovative processes, refines quality high-purity [yttria-stabilized zirconia powder](#) to a significantly reduced grain size, increasing its [strength and optical properties](#). This improved material is then utilized in conjunction with proprietary processes to create monolithic zirconia BruxZir Milling Blanks for the fabrication of virtually chip-proof BruxZir Solid Zirconia crowns, bridges and implant restorations.

While zirconia has many applications in an array of fields, including energy, telecommunications, steel, mining, oil field supply and aerospace, [the lab's reformulation of the material, including advances in nanotechnology, has been recognized as groundbreaking](#). The strength, high fracture toughness, resistance to thermal shock and translucency of BruxZir Solid Zirconia dental restorations have contributed to its rampant success in the dental profession.

When BruxZir restorations are milled from BruxZir Milling Blanks, not all of the refined zirconia material is utilized. A 98 mm diameter (12 mm thick) blank (300 grams) yields up to 19 single-unit crowns (1.6 grams each). That means only 30 grams worth of BruxZir material is used, or just 10 percent. The lab cannot reuse this material once it has been sintered because the crystallite

properties expand exponentially, effectively diminishing its translucent properties.

For the past year, the lab's senior director of Research & Development Robin Carden has been researching ways to recycle the remaining 90 percent of unused post-milled BruxZir Milling Blank material. "We have been searching for ways to recycle our post-milled BruxZir material since March 2010," explained Carden. "Because zirconia is wear-resistant and able to withstand high temperatures, this material is ideal for applications such as molten metal nozzles, oil field valves and high temperature insulation.

"By recycling this material, Glidewell Laboratories is reducing its carbon footprint and allowing this material to be repurposed and reused for other applications that involve high temperature, thermal shock, corrosion, and high wear and impact," Carden added.

Glidewell Laboratories is pleased to launch this recycling program, which will allow other industries to benefit from zirconia's unique material properties. Additionally, the lab will invite its more than 100 Authorized BruxZir Laboratory partners to participate. For more information about BruxZir Solid Zirconia, please visit <http://www.bruxzir.com>.

Glidewell Laboratories, based in Newport Beach, Calif., is a privately owned corporation that has more than 40 years of history as a provider of high-quality services and products to dentists and dental laboratories nationwide. It has its own 73-person Research and Development team and is the most resourceful dental laboratory in the world. Its newly developed CAD/CAM processing capabilities are recognized as among the most advanced in the industry. To view our large selection of products and services, visit <http://www.glidewelldental.com>.



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Posted by Glidewell Laboratories at 4/22/2011 7:25 AM | Add Comment

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### Dr. Gordon Christensen on BruxZir® Solid Zirconia

Dr. Gordon Christensen, in the March 2011 issue of Dental Economics, discusses the rise in popularity of [all-zirconia tooth-colored restorations](#) – specifically calling out BruxZir Solid Zirconia. He explains that while BruxZir is still relatively new to the dental profession, its many benefits outweigh potential risks and provides clinicians and their patients with restorations that are durable, esthetic and affordable. [Click here to read his final verdict.](#)



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Posted by Glidewell Laboratories at 3/24/2011 7:28 AM | Add Comment

## New Online BruxZir® Solid Zirconia Clinical Video

BruxZir Solid Zirconia clinical indications continue to expand as science validates the benefits of this proprietary material. In a new clinical DVD, "BruxZir Solid Zirconia Crowns & Bridges Clinical Indications and Scientific Validation," Dr. Michael DiTolla shares two anterior crown cases and a BruxZir roundhouse bridge case.

Click to watch the new BruxZir clinical video.



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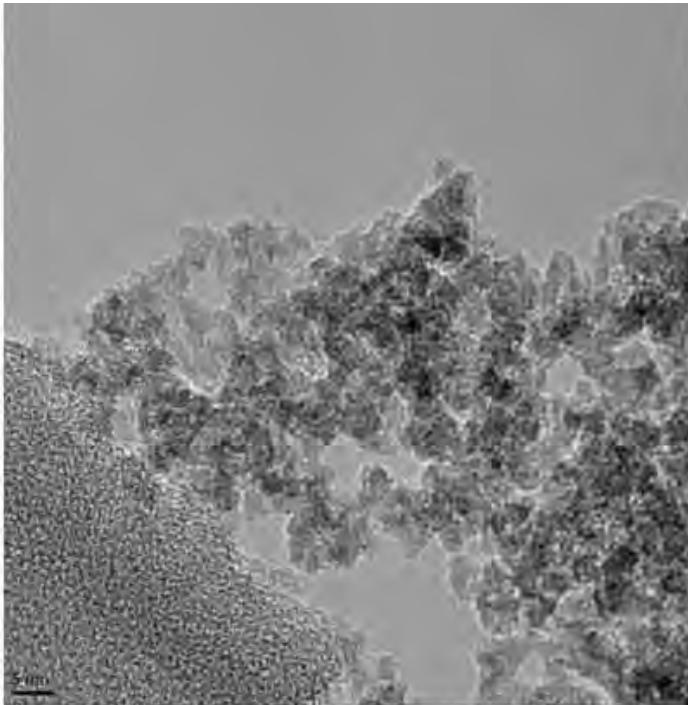
Posted by Glidewell Laboratories at 2/23/2011 9:08 AM | Add Comment

## Glidewell Laboratories Announces Nanozirconia Technology Breakthrough

Glidewell Laboratories, industry-leading provider of [dental lab](#) products and services and manufacturer of [BruxZir Solid Zirconia](#) dental material, Research & Development team has moved closer to producing transparent nanozirconia by successfully synthesizing 3 nm zirconia nanocrystals produced by "bottom-up" nanotechnology.

The research team, led by Ken Knapp, Glidewell Laboratories' program manager and lead researcher, developed a method for producing non-agglomerated 3 nm nanocrystalline zirconia powder using a revolutionary bottom-up nanotechnology technique known as "gas-phase condensation." The focused effort of the nanozirconia research team over the last year has resulted in new discoveries about the nature of sub-5 nm nanozirconia crystals. Glidewell Laboratories has filed a U.S. patent application on the new ceramic nanotechnology (patent pending). This method consists of colliding high-energy yttrium, zirconium and oxygen ions together in an energetic gaseous phase and condensing yttria zirconia nanocrystal particles resulting from atomic collisions during flight in the gas phase. The condensed yttria zirconia nanocrystal particles are separated from the gas phase and collected in the form of nanocrystalline powder. According to Knapp, "The key to making transparent polycrystalline zirconia material is starting with a non-agglomerated yttria zirconia primary crystal size less than 5 nm. Glidewell's new gas-phase condensation nanotechnology for producing nanozirconia will allow us to overcome the fundamental polycrystalline birefringence barrier to manufacturing a transparent, high-strength monolithic dental ceramic product."

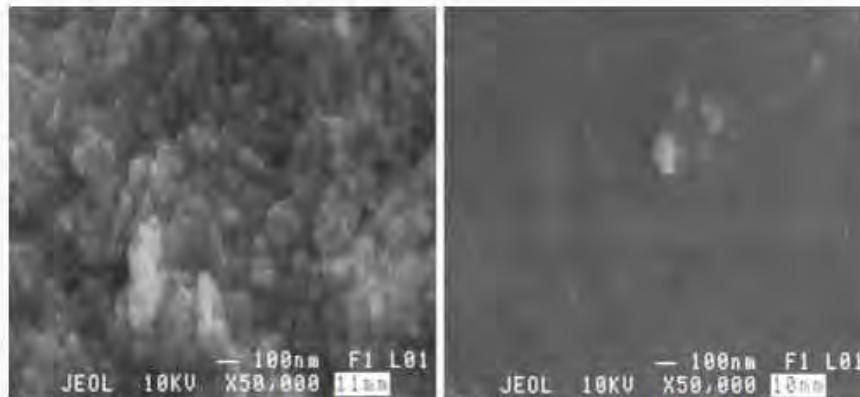
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High-resolution transmission electron microscopy (HRTEM) image of Glidewell Laboratories' 3 nm nanocrystalline zirconia material produced by gas-phase condensation "bottom-up" nanotechnology.

Conventional nanozirconia powder is typically produced by "top-down" nanotechnology methods such as hydrothermal synthesis (calcining followed by ball-milling). Many of the nanozirconia powders available on the market today are comprised of hard-agglomerated nanocrystals with a primary crystal size of approximately 30 nm. After sintering, typical nanozirconia grain size is between 500-1000 nm. The top-down method is widely used to produce nanocrystalline materials by breaking down larger particles and agglomerates into smaller ones, typically by ball-milling. The bottom-up nanotechnology method builds up nanoscale materials atom by atom or molecule by molecule. Bottom-up nanoscale science and technology is the state of the art for producing the next generation nanoscale materials and devices. The bottom-up method has a lower scale limit on the atomic or molecular level. Additionally, the bottom-up-produced nanocrystalline structures are not altered during the process of forming the nanoscale crystals, whereas top-down methods alter the crystal structure and surface chemistry.

Robin Carden, senior director of Glidewell Laboratories materials research and development said, "Glidewell's nanozirconia material produced by the gas-phase condensation method overcomes the inherent sub-5 nm crystal size production barrier and hard-agglomeration formations found in conventional nanocrystalline ceramic processing."



Scanning electron microscopy (SEM) image of dry-compacted nanozirconia (fractured cross-section) comparing 3 nm hard-agglomerated conventionally produced nanozirconia (left) to Glidewell-produced 3 nm nanozirconia material (right).

Common **zirconia dental ceramics** are translucent and not transparent as a result of light-scattering during transmission by birefringence and porosity. Light-scattering by birefringence is an intrinsic property of polycrystalline optical materials with an anisotropic crystalline index of refraction. Birefringence is reduced dramatically when the sintered grain size is reduced below 100 nm. Porosity causes light-scattering in the visible spectrum between 400-700 nm, which reduces the zirconia optical transparency.



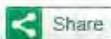
Optical microscopy image of dry-compacted nanozirconia (fractured cross-section) comparing 3 nm hard-agglomerated conventionally produced nanozirconia (left) to Glidewell-produced 3 nm nanozirconia material (right). Conventionally produced 3 nm nanozirconia material is white opaque, whereas Glidewell's gas-phase-condensed nanozirconia is transparent after compaction.

The future for high-strength esthetic nanozirconia is agglomerate-free sub-5 nm powder. James Glidewell, CDT, CEO and president of Glidewell Laboratories said, "Our continued nanozirconia research efforts, from the fundamental way that zirconia nanocrystals are formed to new sintering methods, will allow us to extend our BruxZir® product life into the next generation of nanocrystalline dental ceramics."

For a closer look at BruxZir Solid Zirconia, visit [www.bruxzir.com](http://www.bruxzir.com).

Glidewell Laboratories is a privately owned corporation that has more than 40 years of history as a provider of high-quality services and products to dental laboratories nationwide. It has its own 73-person Research and Development team and is the most resourceful dental laboratory in the world. Its newly developed CAD/CAM processing capabilities are recognized as among the most advanced in the industry. To view our large selection of products and services, visit [www.glidewelldental.com](http://www.glidewelldental.com).

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Posted by Glidewell Laboratories at 2/14/2011 7:44 AM | Add Comment

### BruxZir Anterior Case

We are continually seeing more and more dentists placing BruxZir Solid Zirconia in the esthetic zone. Below are photos from a BruxZir anterior case, sent to us from a dentist and milled by one of our [authorized BruxZir labs](#).

*"This patient's anterior case came out great. I just wanted to share the before and after photos with you. BruxZir keeps surprising us."*

Before





After



– Janet S., DDS, Oaklawn, IL  
Ceramics by [Precision Ceramics Dental Laboratory](#), Montclair, CA

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Posted by Glidewell Laboratories at 2/1/2011 10:22 AM | [View Comments \(1\)](#) | [Add Comment](#) | [Trackbacks](#)

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### Hammer Test: BruxZir® vs PFM

Having survived countless hours of rigorous scientific testing at the hands of Glidewell Laboratories' [award-winning R&D department](#), BruxZir® has been called "chip-proof," "bullet-proof," and "virtually unbreakable." Never satisfied, we decided to up the ante by pitting it against a traditional PFM in a less conventional test we dubbed... the Hammer Test.

[View the Hammer Test: BruxZir® vs PFM video](#)

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Posted by Glidewell Laboratories at 12/23/2010 10:10 AM | View Comments (1) | Add Comment

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### Technical Update: Do Not Use Discs To Finish Full-Contour Zirconia

As more and more dentists prescribe [BruxZir restorations](#), we would like to review some critical areas in designing and finishing bridgework. Recent data shows BruxZir single-unit fractures are the lowest of any product in Glidewell Laboratories' history, with PFM bridges showing three times the fracture of BruxZir. However, when the lab does see a fractured BruxZir bridge, it is almost always due to: 1) A diamond disc being used to separate connectors, effectively "scoring" the ceramic and increasing the odds of a failure starting at this point, or 2) Violation of the "Rule of 27" for determining connector dimensions.

It is very important not to make any adjustments to BruxZir bridges after coloring and sintering. The temptation to finish and enhance the esthetics of bridge connectors by opening embrasures can lead to failures, especially when using a diamond disc. Beyond running the risk of violating the "Rule of 27" (see below), the disc creates sharp lines that may lead to cracks and imminent bridge failure. As illustrated in the 5-unit BruxZir bridge case below, by enhancing the visual separation of the interproximal areas, a fatal weakness was introduced.







The size of the connectors is of paramount importance. We recommend you follow the Rule of 27 to ensure that the bridge will withstand the tremendous loads applied in the oral environment. When considering the cross sections of the connectors, the load carrying capability of a bridge is proportional to the height squared multiplied by width ( $=h^2 \times w$ ). As a result, the Rule of 27 has proven to be the minimum acceptable load capacity.

**Example 1:** A BruxZir bridge has 3 mm high x 3 mm wide connectors.

$3 \text{ mm}^2 \times 3 \text{ mm} = 3 \times 3 \times 3 = 27$ . This bridge will be able to carry a proportional load in the oral environment, according to the Rule of 27.

**Example 2:** A BruxZir bridge has 4 mm high x 2 mm wide connectors.

$4 \text{ mm}^2 \times 2 \text{ mm} = 4 \times 4 \times 2 = 32$ . This is an even better outcome.

**Example 3:** A BruxZir bridge has 2 mm high x 4 mm wide connectors.

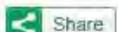
$2 \text{ mm}^2 \times 4 \text{ mm} = 2 \times 2 \times 4 = 16$ . This outcome of only 16 is insufficient.

Following the processes outlined above will ensure that your **BruxZir crowns & bridges** live up to their reputation of being virtually "bulletproof."

Questions? Please call Glidewell Direct at 888-303-3975.



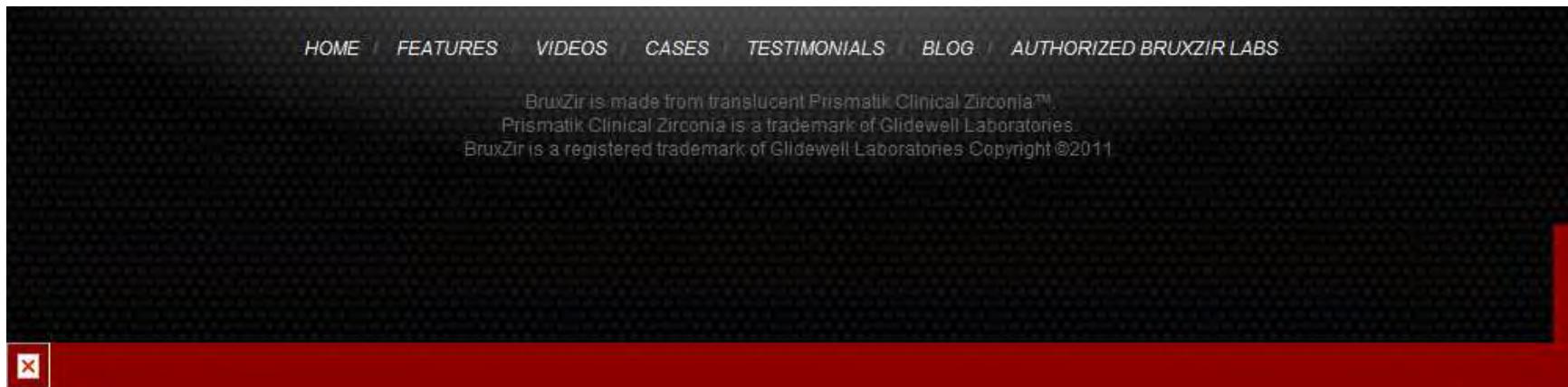
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**ONE-ON-ONE INTERVIEW**  
*of Dr. David Hornbrook*

By [Michael C. DiTolla, DDS, FAGD](#)

It was my pleasure to interview one of my clinical mentors, [Dr. David Hornbrook](#), for this issue of Chairside magazine. David is someone whom I have followed since I graduated from dental school, when I started taking his courses at Las Vegas Institute for Advanced Dental Studies (LVI), PAC~live and the Hornbrook Group. Over the years, I've continued to follow David and look up to him as a clinician and friend.

*Dr. Michael DiTolla:* Good morning, David, it's wonderful to have you here with us.

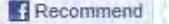
**Dr. David Hornbrook:** Thanks, it's great to be included.

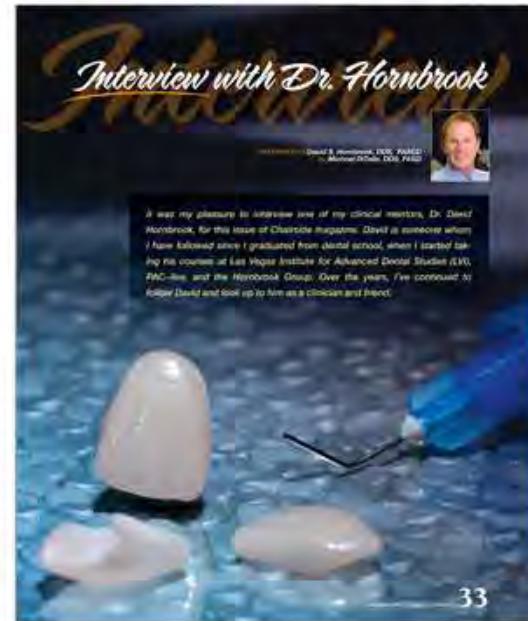
*MD:* People always say, "Now is the best time to be a dentist." (With perhaps the exception of the 1960s, before the air-driven handpiece was invented and everything was belt-driven.) But as I reflect on my more than 20 years in practice, it seems that things just continue to get better. Do you feel that 2011 is a great time to be practicing dentistry?

**DH:** Absolutely. There are two things we need to look at. One is, obviously, that the economy has changed a little bit. There may be people reading this who say, "I'm not doing what I was doing two years ago in smile designs and discretionary dentistry." But if we eliminate that aspect of it, this is the best time to be a dentist.

The advantage of where we are now is that we are no longer faced with the many limitations and compromises we've historically faced during treatment planning. Materials are more esthetic, and adhesive dentistry has allowed us to be more conservative. Today, the only limitations we face are those of the clinician's imagination.

*MD:* Well, let's back up to what you said about the economic slowdown. I can tell you that, at least from the lab's perspective, the economic slowdown over the past two years did happen – you are right on the money. If we look at our veneer sales, they definitely decreased over that time period. No one is imagining that. This isn't a rumor running rampant through dentistry; there was a serious

 1   [PRINT](#) [E-MAIL](#)

 **Interview with Dr. Hornbrook**  
 David S. Hornbrook, DDS, FAGD  
 Michael C. DiTolla, DDS, FAGD  
 It was my pleasure to interview one of my clinical mentors, Dr. David Hornbrook, for this issue of Chairside magazine. David is someone whom I have followed since I graduated from dental school, when I started taking his courses at Las Vegas Institute for Advanced Dental Studies (LVI), PAC~live, and the Hornbrook Group. Over the years, I've continued to follow David and look up to him as a clinician and friend.  
 33

*cutback in the number of elective cosmetic procedures.*

*Over the past two years here at the lab, only a couple of products have grown. One of them is an esthetic product (in the sense that it's a great-looking product): [IPS e.max®](#) (Ivoclar Vivadent, Amherst, N.Y.) crowns. IPS e.max veneers have grown as well. People obviously still need full-contour restorations, so those may not be elective. At any rate, IPS e.max has continued to show an impressive growth curve over the last couple years. I'm guessing you're a pretty big fan of this product. Tell me a little bit about the impact IPS e.max has had on your practice.*

**DH:** You are absolutely right to say that I'm a big fan of [IPS e.max](#). It's an unbelievable material. For those readers who aren't familiar with this product, IPS e.max is a lithium disilicate material that can be waxed and pressed or fabricated using CAD/CAM.

*When waxed and pressed, kind of like we've done with [IPS Empress®](#) (Ivoclar Vivadent) and leucite-reinforced ceramics for the past 20 years, we use the lost-wax process (just like we'd cast gold). [It can also be made using CAD/CAM technology](#), whether in the office with CEREC® (Sirona Dental Systems; Charlotte, N.C.) or E4D (D4D Technologies; Richardson, Texas), or in the dental laboratory.*

[IPS e.max](#) has filled an existing void in dentistry. It is a highly esthetic material – as you mentioned, it approaches the esthetics of anything we have in dentistry right now – and it's amazingly strong. We now have a ceramic that's four times stronger than the ceramic we've put on PFMs for the last 60 years. I mentioned earlier about options in treatment planning: Now I can look at even a second molar on a [bruxer](#) that has decreased vertical dimension and give the patient a restoration that is esthetic, conservative and strong.

*MD: I distinctly remember placing my first [IPS e.max](#) crown. It was on a friend's wife, and it was at the end of a two-year period in which I did nothing but zirconia-based restorations. We were struggling to blend the zirconia restorations with the adjacent teeth because we were dealing with coping shade issues and with dentists under-reducing teeth, especially in the gingival third.*

*When lithium disilicate came out, I must admit I was a little suspect. Ivoclar was releasing this material for the third time, and I wondered if it would work. The first [IPS e.max](#) crown I put in was so beautiful that it blew me away. It was the kind of thing you looked at and said, "Wow. If this is going to stand up to the types of wear and tear we see in the mouth, this material is going to be successful."*

*How neat is it that a material can be used for almost any clinical indication – inlays, onlays, crowns and even veneers? I recently heard a rumor that some of the esthetic institutes were thinking of switching over to [IPS e.max](#) veneers. What are you teaching in your clinical course now, and how do you feel about [IPS e.max](#) veneers?*

**DH:** Well, by the time this article is published, my opinion may change based on the fact that Ivoclar is introducing even better ingot and block shades. I know some people will read this and say: "IPS e.max? It's kind of gray. It's kind of opaque. It doesn't look as good as [IPS Empress](#) ..." That was the [IPS e.max](#) of a year and a half ago, when Ivoclar didn't have available the many translucent and esthetic ingots that are now offered for CAD/CAM or for pressing. And now they've introduced ingots that mimic what we've always seen with Empress, which is what I would call my standard for anterior esthetics. To answer your question, today I'm still a fan of [IPS Empress](#) in the anterior and it is still my "go to" material. If you came into my office or into my teaching center and you were going to do six, eight, 10 veneers, [IPS Empress](#) would still be my first choice. I just think it interacts with light a little better than lithium disilicate. But as we get more experience with the new Value ingots, that preference may change. I seated 10 maxillary anterior veneers this week using the new V1 ingot, and the case was beautiful.

*We are also now doing prepress and very minimal-prep [IPS e.max](#) veneers, because at 0.2 mm or 0.3 mm thin, this*

material exhibits incredible marginal integrity. Even being this thin, they are very high strength and very easy for the laboratory to finish down at the margins. We're doing anterior 3-unit bridges in IPS e.max, and we're getting esthetics that approach IPS Empress. So we're still teaching IPS Empress. But, then again, three months from now when you ask me this question I might say, "Who's using IPS Empress anymore? Not me." This is what makes dentistry so exciting and fun!

*MD: My personal viewpoint is that if I've got to do a veneer on tooth #9, and tooth #8 is a virgin tooth, I am going to use IPS Empress. Like you, I don't think there's anything as lifelike as IPS Empress somewhere between 0.3 mm and 0.6 mm thick. It just looks more like natural tooth structure than anything else. But I've started to change a little bit – and I'm not as demanding esthetically as you are. When I get to an 8-unit veneer case, I like the idea – and we can see from the numbers that dentists liked the idea, too – of having a veneer material that's three times as strong as IPS Empress. Dentists have had problems with chipping and they've had some breakage. Maybe it was due to poor prep design or not checking the occlusion close enough, but dentists seem to like the idea of having a stronger material. And, of course, when you have six, eight, 10 veneers lined up next to each other, it's not the same kind of thing as it is with a single tooth. Do you think that's a reasonable approach for the average dentist?*

**DH:** Absolutely. Not even for the average dentist – every dentist. If we can deliver a restoration that is two to three times stronger than anything else we can offer and it doesn't compromise esthetics, I think that's definitely the way to go. We're looking at this material very seriously. I mentioned that Ivoclar just introduced its IPS e.max Press Impulse Value ingots. I did another case recently using these V ingots – two cantilever bridges replacing laterals off the canine and then eight other veneers – and it was absolutely beautiful. I actually had the lab make two sets: one IPS Empress and one IPS e.max. After trying in both cases, I chose IPS e.max. Needless to say, we're very excited about this material.

*MD: I agree, and dentists are certainly voting here at the laboratory with their wallets, as well.*

*I remember one morning about a year ago, I opened a journal and there was Dr. David Hornbrook doing a no-prep veneer case! I wasn't sure if this was a hostage situation in which you had a gun to your head, but I was caught so off guard that I spilled my coffee; I didn't know what might have prompted this. I have a feeling it's material advancements. And, of course, as somebody who performs such esthetic services as yourself, the abuse of the no-prep veneer concept was probably something that bothered you a little bit. But I really thought it was a great sign. And you – being so open-minded to go forward and try one of these cases, and then publish the case! It was a gorgeous case, by the way.*

**DH:** Well, thank you. I think preplex or very minimal prep veneers are a technique that every dentist needs to explore. Obviously, it's public-driven because a major dental manufacturer markets preplex veneers to the public, so now patients are asking for this procedure. But I think it's been abused. We see very compromised results with this technique more often than not. You work with a dental laboratory, so you understand the importance of the communication process. The communication between the ceramist and the dentist is so crucial. I think a lot of dentists were, and still are, doing these preplex veneer cases without really understanding the indications and contraindications of this procedure, and we see some really ugly and even unhealthy cases, especially tissue-wise.

I practice dentistry three to four days a week, and my patients were asking about these preplex veneer cases. And I really wanted to explore this more closely: Was it the material itself, the lack of case planning or the technique? So I went back and worked with laboratories and materials and ideal cases. Together we established some planning protocols that have yielded some surprisingly unbelievable results, esthetically and functionally, with preplex veneer cases. It's an opportunity available for patients and doctors. As I teach, I find that a lot of doctors refuse to prep virgin enamel. This refusal limits their ability to offer their patients some beautiful smiles. Preplex veneer cases, when planned properly, are a viable alternative to prepped veneers.

*MD: That's interesting. I've never heard a dentist say, I refuse to prep virgin enamel. If somebody were to make that argument, I would have to assume they were probably doing lots of inlays and onlays. We certainly see lots of virgin enamel on very healthy cusps being prepped in the name of insurance- approved crown & bridge. I don't know why they would find it to be different just because it was in the anterior. You know what I mean?*

**DH:** I totally agree. But I hear and see it all the time. I see dentists who will prep a full crown instead of an inlay. Or they'll prep virgin teeth on each side of a missing tooth to place a 3-unit bridge, but they won't do a 0.5 mm depth cut on an anterior tooth. It amazes me.

*MD: To me, no-prep veneers really are a great finishing technique. I do hardly any no-prep cases where all eight or 10 units are no-prep veneers. But I do see cases where we will replace, say, old PFM's on tooth #7 through tooth #10 with some IPS e.max crowns. And then I will place no-prep veneers on the cusps and the bicuspids and finish out the whole smile without having to do any additional preparation. That's what I mean by a finishing technique. It is a great way to finish out a smile when it's done in conjunction with other restorations.*

**DH:** I agree, especially in this baby boomer age. A lot of these people went through ortho as a teenager and had their first bicuspids extracted. Now their posterior quarters are collapsing and they want a nicer looking anterior smile because of wear or discoloration. You can do veneers, or you can replace existing crowns and then place very conservative veneers on the premolars and develop a beautiful smile.

*MD: When I first learned about esthetic techniques in your courses (back in 1995), we were doing fairly aggressive preparations in the dentin when placing IPS Empress veneers. And, as time has gone on, I have found that because of improvements in ceramic materials, we can achieve similar results with less reduction, assuming that the tooth is not way out of an ideal arch form and it's just an esthetic issue. I like the idea of minimal-prep veneers, which, to me, is something that has all the margins still in enamel. I like the idea of bonding to enamel and keeping it intact. Do you find that minimal-prep veneers, where you're not necessarily exposing dentin, are something that you are using more on a day-to-day basis?*

**DH:** When I first started teaching, around the time you went through my courses, I think it was also the inexperienced ceramist who established some of the "ideals" of veneer preparation. IPS Empress was new to ceramists. It was a monolithic material. They didn't really understand how to use the different opacities and translucencies in a very thin environment. So they said, give us some more room because we just don't get it. And we would prep 0.7 mm to 1 mm, and they would want the contacts broken. It was a new concept to them. We were teaching very aggressive preps in the mid 1990s. In the last four or five years, we've really done an about face. And what we recommend now is 0.3 mm to 0.5 mm depth cuts, assuming that the tooth is ideally positioned in the arch. So, unlike in the past, when most of my preparation for a veneer was in dentin, most of it's now in enamel.

*MD: Do you find that you enjoy bonding to enamel more than dentin, or is it not a big issue for you? I hear from dentists, whether it's postoperative sensitivity or not being sure how much they're supposed to dry the tooth off, that they really like the idea of etching enamel. Being able to dry it to your heart's content, see that nice frosty look. For those of us who are kind of old-school dentists, it feels comfortable in a sense. It's something that we grew up with.*

**DH:** Personally, I don't really have a problem bonding to dentin. We've been doing it for almost 15 years, and I feel the predictability is there. But, I agree: I think that dentists still struggle, even to this day, with this whole total-etch and how wet is wet and how dry is dry concept. Most clinicians feel a little more comfortable being able to etch, rinse and dry as much as they want and get success. I think we're going to see increased predictability, less standard deviation and less failure when the restoration is primarily in enamel.

*MD: I actually think that we'll see more of these restorations diagnosed. Obviously, there's talk of over-diagnosis of veneers, but I think that's by a small percentage of dentistry. Many dentists still don't talk about this type of esthetic dentistry because they're not*

totally confident in their ability to get a great non-sensitive result doing it completely on dentin. They seem to like the idea of bonding to enamel, and they know it works, and they get less post-op sensitivity. As a result, they're going to be more confident in their procedures.

DH: I agree with you.

MD: Speaking of total-etch versus self-etch, for your direct-placed restorations in the posterior, are you using self-etch at all? Or are you still a total-etch guy?

DH: I'm definitely a total-etch guy! In fact, I've actually gone back to fourth generation dentinal adhesive systems. So, I etch, and then utilize a separate solution for the hydrophilic primer and a separate solution for the hydrophobic adhesive.

MD: So you're back to the regular two-bottle system. What are you using?

DH: I'm using [ALL-BOND 3®](#) (Bisco Inc; Schaumburg, Ill.). I like Bisco products and respect Dr. Byoung Suh and the research being done at his company. If I look back historically, what I would consider the gold standard would be ALL-BOND 2 and [OptiBond® FL](#) (Kerr Corporation; Orange, Calif.). And the only problem, at least that I saw, primarily as an educator, was that ALL-BOND 2 was acetone-based, so it was a little more finicky. What Bisco did a few years ago was change the hydrophilic carrier to alcohol. Now we have what I would consider a new gold standard. It's alcohol based, and you can use it for every type of restoration you place in your office. Too many clinicians have too many bonding agents in their refrigerator. Unless they can get an adequate amount of light to polymerize the material, anything but a fourth-generation adhesive will lead to a compromised result.

MD: It really is kind of funny. I don't know how many times in dentistry we've seen dentists take a step backward from what the latest and greatest is, with maybe the exception of digital impressions, which tend to be more difficult and more time consuming than conventional impressions. You look at the way things went to one bottle and then all of a sudden we have self-etching in one bottle. It began to look like, "Wait a minute. Are we doing this for us, are we doing this for the quality, or are we doing this for our patients?" So it's interesting to hear that you've gone back to something that's time tested and proven. It does take a little more time, but you feel it's better. I know you're not going to go back to a self-cure composite instead of light-cure composites or a belt-driven handpiece. You must really feel in your heart that this is the right thing to do.

DH: I do. I have not seen the sensitivity that a lot of people saw with the total-etch. Obviously, we're isolating and controlling that surface moisture, not over-etching the dentin. But it's something where I have predictability; I have success; I don't have much postoperative sensitivity; I don't see premature failure; and I can look back and show you 15 years of clinical experience, as well as excellent research.

The problem with today's bonding agent chemistry is that it changes too fast. You'll see a study on a self-etching primer that bonds to enamel that was carried out over a period of 36 months, and that material has changed chemistry since the article came out. So we can't look at these and say this is going to have long-term success, where we can with total-etch systems.

MD: Does this mean that you have not played with any of the self-etching flowable composites yet?

DH: I've played with them, but I haven't used them clinically except to alleviate sensitivity in gingival abfraction lesions.

MD: Yeah, I get it. If they work, it seems like a huge step forward for a dentist to be able to place things this quickly. But you always have to ask yourself: Is this about what's convenient for me or is it about what's better for the patient? And it may be different in the hands of the average dentist than it is for you.

status of the average dentist and it is for you.

**DH:** Again, I personally think the problem with some of the self-etching resins, and even the resin cements, is that the manufacturer can show us this great data, but what does it really do clinically in an environment on a live, vital tooth? I won't name names, but there's a product that is highly touted by the manufacturer as the best self-etching resin cement on the market. When zirconium oxide first came out, we had a lot of failures because we were using the wrong layering material, until it failed. So I cut off 45 zirconium oxide crowns utilizing this cement that supposedly bonded excellently to dentin. And every single one I cut off, the cement just peeled away in large sheets. There was zero bond. So we have got to ask ourselves: Are the materials that show great benchtop success on non-vital teeth done in a controlled environment giving us the same clinical success in the mouth in a very hostile environment?

**MD:** Right. And there is always going to be a disconnect between the two. I think you may be in second place behind me for the number of zirconia restorations cut off. I know I've cut off more than that. Some of the zirconia crowns I've cut off have actually been our new [BruxZir®](#) material. BruxZir is a monolithic zirconia restoration that, shockingly, dentists are prescribing in record numbers. Believe it or not, BruxZir actually passed IPS e.max in sales volume in November 2010. The ongoing wear studies at a couple of universities look encouraging, but you can imagine, having cut off zirconia-based crowns, what it might be like cutting off a full-contour zirconia crown! I have always thought this is something we need to talk about a little bit more. In fact, I remember you calling me once and saying, "Well, what if you have to do endo through one of these zirconia-based crowns?" And, at the time, we didn't have a good set of diamonds. But now we've found some good diamonds to be able to cut those off. Are you using many zirconia-based restorations right now in your day-to-day practice?

**DH:** Lithium disilicate has replaced my zirconium oxide-supported crowns in the posterior. At one of my most recent lectures, a ceramist said IPS e.max has destroyed his [Lava™ \(3M ESPE\)](#); St. Paul, Minn.) market, which makes sense! I still use zirconium oxide-supported crowns for posterior bridges and three units in the anterior. I do pride myself on trying to be metal-free as much as possible, and that's the only option I have. But single units, whether it be full zirconium oxide or zirconium oxide-supported with layering ceramic, I rarely ever do those. I do IPS e.max.

**MD:** If you look at the history of indirect restorations in dentistry, of course cast gold was the first material out there – a monolithic material. Then, porcelain jacket crowns, which left a lot to be desired in terms of strength, but it was still just one material. Even back in the 1960s, there became this need to have something that was more esthetic than gold. We can talk about the current esthetic desires in Southern California, but even back in the 1960s there became a need to take a metal coping and fuse it to porcelain.

The PFM has been the workhorse of dentistry for the last 40 years. It's driven American dentistry, this laboratory, and almost all laboratories, for that matter. But PFMs have always suffered from the problem of having porcelain bonded onto the metal substructure. And with this bilayered restoration, there is always a chance that something can go wrong. In fact, it's rather amazing that a lot of the times nothing did go wrong with the bond between the two. But, by nature, a bilayered restoration is going to have more problems than a monolithic restoration. I think we finally saw that with the ceramic-bonded-to-zirconia market. Whether because of the coefficient of thermal expansion or the way people were fusing the two parts in the oven, there was going to be issues with compatibility and chipping. So, we've seen the same thing: IPS e.max, a monolithic material, and the monolithic BruxZir material introduced after it have destroyed the zirconia market. Again, the average dentist appears to be doing the same as you, at least in that respect.

You've always struck me as a guy who would probably have a CEREC® (Sirona Dental Systems; Long Island, N.Y.) machine in his practice. I've seen some of the artful direct composites and killer temporaries you've done, and you've always work with the best ceramists to get great results on your final restorations. You really are as much of a lab tech as any GP I know, but I don't know that you ever fully embraced CEREC. Do you have a unit now that I don't know about?

**DH:** Actually, I do! But I've only had it for two weeks. I've done only four crowns. I was waiting for the camera to be better and for the software to be a little more intuitive before I took the plunge. It has been worth the wait.

~~SECRET AND NOT FOR DISCLOSURE TO BE A LITTLE MORE INTRUSIVE BEFORE I TOOK THIS PICTURE. IT HAS BEEN WASHED AND WORN.~~

When the 3M ESPE Paradigm™ Block came out several years ago, I was lecturing a lot on inlays and onlays. And 3M said: "Hey, we'll send you a CEREC. Start doing the Paradigm Block and when you love it, you'll talk about it." Well, I hated the CEREC machine. It was so counterintuitive. After three weeks, I sent it back and said, "I'm not using this!"

*MD: When was that?*

DH: Maybe seven years ago? Whenever CEREC 3 came out. But now I'm looking at the software and looking at the camera, looking at the whole technology of digital impressions (which is obviously the future of dentistry), and it makes sense. You're right in the fact that I do like to play with ceramics, but I'm not nearly to the level of expert ceramists. I can't make a veneer or an anterior crown look the way they can. But the fact is we're using monolithic IPS e.max in the posterior where I'm not having to cutback or layer because I want strength. I'm getting good esthetics with monolithic material. After all, the lab was just waxing and pressing or milling it to full contour and superficially staining it. I thought, why am I not doing that?

*MD: I wasn't praising you so much for veneers; I was complimenting your anterior direct temporaries. I would never take an impression and send it to you and say, "Hey, make my veneers."*

DH: I wouldn't either!

*MD: But I've seen what you can do on posterior teeth with direct composite, and it did seem like you are the kind of guy who would mill IPS e.max restorations in the posterior. You've always offered such great services to your patients. At Glidewell, we've now got six CEREC machines and probably 10 additional MC XL mills. I've got a CEREC AC in the operatory and I am convinced – here I am practicing in a lab, but regardless – I am convinced that one-appointment dentistry is better than two-week dentistry.*

DH: I've only done four of these, so I'm not great at it yet. It's like, how do I schedule it? One to two hours for a single unit? How long is it going to take me? But for the people who are great at it, I think it's a huge advantage. I see this technology as an advantage for even a three- or four-day turnaround versus two weeks. Yes, we're good at making temporaries; that's what we've always done, and we're good at it. But if we use this technology, we get reduced lab costs, improved turnaround time (whether that be 1.5 hours or three days) and total control.

Let me give you an example. On the third CEREC crown that I did, an IPS e.max crown, I decided to try it in and adjust occlusion in the blue block state before it was sintered. And the patient bit down and broke the crown! In the past, had I sent that crown to Glidewell and it was IPS e.max or IPS Empress, I would have made a temporary, sent it back, and you would have made me a new one. Well, the cool thing about CEREC is that it was in my library. All I had to do was go back to the library, click it again, and in eight minutes I had a new crown! That's where there is a huge advantage. Or say you have a material that you put in and there is a marginal discrepancy. Instead of taking a new impression, you can take a new digital impression and do it in three minutes.

*MD: I agree. That's a better way to say it. I mean, it's true; I do believe that one-appointment dentistry is better than two-week dentistry. But I also believe that three- or four-day dentistry is better than two-week dentistry. And I believe two-week dentistry is better than six-week dentistry! The shorter period of time between prep and seat the better because of bacterial leakage, teeth shifting and factors like that.*

DH: And also the fact that today we are doing more conservative dentistry. The primary complaint with some of the crazy little single-cusp replacement onlays that we do is, how do you keep temporaries in? It's a pain! If you plan to see this patient in three weeks, more than likely you're going to see them twice in the next three weeks to re-cement the temporary. And if I can do it as either a single visit or get it back in two or three days because I milled it myself, we're

not going to have problems with provisionalization.

*MD: Right, because patients don't want to come in three times. And, frankly, you've blown any profit you might have made on that case after three visits.*

*It's funny you mention reduced lab costs because here at the lab we are all for that. We want to reduce lab costs. I mean, of course we'd like to work with more dentists, but primarily we'd like to reduce lab costs. We're getting ready to release, most likely at the Chicago Dental Society Midwinter Meeting, a digital impression system that we will sell to dentists for their practice. We're looking at it as an IPS e.max/BruxZir wand, if you will. So, for monolithic restorations, a dentist would take a digital impression, which we realize is more work than a regular impression. To me, to take a digital impression if it's not hooked to a mill is kind of silly, unless it's going to save you money. And some of the other digital impression systems actually cost you money. It's very difficult for you to get any ROI with those systems.*

*With the Glidewell system, we're talking about taking a digital impression and sending it to the lab. Submitting the digital impression this way saves the dentist \$27 on the cost of the restoration. There is no one-way shipping cost (\$7 savings), no cost for impression material (\$10 savings), and the lab discounts \$10 because it can be digitally fabricated. So, we do want to reduce lab costs to dentists by cutting out some of the steps by making these model-free crowns.*

*You and other CEREC users have proven that model-free crowns can be made, and Sirona has 25 years of experience doing it. We know it works. Have you used many of the other digital impression systems, such as [Cadent iTero™](#) (The Cadent Company, Carlstadt, N.J.) or Lava C.O.S.?*

*DH: I haven't used Cadent clinically. I've played with it chairside and it seems like one of the easier systems to use. I know a lot of laboratories prefer it. And I like the technology of the Lava C.O.S. system, but it's very time consuming. We looked at it, we were going to buy it, and then we decided not to. As we talked to colleagues, some of my friends that are excellent dentists, a lot of them had sent it back. It's not that it wasn't accurate or that its technology wasn't cool. But if it takes 40 minutes to take an impression, it's not profitable.*

*You mentioned the cost savings of shipping, and that's something that a lot of dentists don't look at. If they say, oh, I only save \$10 by doing that, what they don't take into account is the money saved in outgoing shipping. They will also get a better turnaround time because instead of taking two and a half days to get it to you, the case arrives at the lab instantly.*

*MD: Exactly. I don't like it when dentists are kind of force-fed technology or when dentists are told they are not doing great dentistry if they're not using this technology. For example: On your polyvinylsiloxane impressions, do you perceive that you have a big problem with them day in and day out?*

*DH: Not a major problem, but I think that if you really looked at the weakest link in the chain of restorative dentistry, it would be the impression and the pour-up in crummy dental stones. But is that going to keep my restorations from lasting 10 years or more? No. We have more accurate materials today than we did 20 years ago, when dentists were doing gold crowns that were in the mouth for 40 years. So, I totally agree with you on that.*

*MD: That's why I feel that if the digital impression system is not tied to a mill, where you can do same-day dentistry or three- or four-day dentistry and save nearly \$20 per IPS e.max crown through a lab, what's the point of going through the extra effort to do something like this?*

*What are you using for a diode laser these days? And I'm guessing you have a hard-tissue laser, as well?*

*DH: I use a diode laser. I don't do any dentistry, just basic oral health care in each appointment. As far as business, I have another dental*

**DH:** I use a diode every single day in my practice, we have one in each operatory. As far as hygiene, I personally think that use of a laser is standard of care. Dentistry as a whole will realize that in a few years.

The advantages of present-day diodes compared to the ones we used are that they are affordable and smaller. You can get a good laser for less than \$5,000; all of a sudden, lasers are very affordable.

We're also doing closed-flap osseous using an [Erbium:YAG laser](#) (AMD LASERS, LLC; Indianapolis, Ind.), which is very cool. So we're performing crown lengthening without laying a flap, and we're getting unbelievable results. Lasers, just like digital technology, are going to change the way we practice dentistry as they become more affordable and more dentists adopt the technology.

**MD:** Do you feel pretty confident with closed-flap crown lengthening? I know it drives some periodontists crazy – it's hard to treat what you can't see. But I have to say that biologic width violations are a real problem. As you walk through the laboratory and look at anterior models, you see interproximal violations left and right. You know the crowns probably look pretty good, but the tissue is purple interproximally because the prep outline doesn't follow the gingival outline. Are you doing most of these in the anterior or posterior?

**DH:** I do it just in the anterior because I can tactfully feel the bone and make sure I'm not troughing or creating an artificial biologic width. Because posterior bone is thicker, I don't do it. I refer that out if it needs to be done. I was keeping track of repercussions up to 2,500 teeth, and then I stopped, but we've had zero repercussions. I've done it in all my courses since 2004, and we've seen no problems. The cool thing is that unlike traditional crown lengthening, where a flap is laid and a diamond bur is used on the bone and then you wait 12 to 16 weeks, we're prepping and impressing and provisionalizing on the same day that we do our osseous. We're doing some fun, really cool things with that.

**MD:** Maybe in a perfect world every patient would be flapped and you'd see directly what you were doing. But the reality is that most of these cases have biologic width violations and dentists aren't doing anything. They're taking the old crown off and putting a new crown on. If anything, the margin gets dropped just a little bit further as the doctor goes in and cleans the cement off the prep, so the biologic width violation gets a little bit worse. I think you're seeing good results because it's a step in the right direction. It may not be 100 percent perfect, but maybe the patient wouldn't have had it done surgically anyway. I think that some treatment to improve biologic width is better than no treatment at all.

**DH:** That's right.

**MD:** You mentioned that you do closed-flap crown lengthening procedures during your courses. Tell me a little about the courses that you're putting on today.

**DH:** The best source for those who are interested in where I'm going to be as far as a lecture or hands-on course is to visit [www.davidhornbrook.com](#). Click on "Calendar," and it will go through the things we're doing. I still do a lot of full-day lectures across the country, and that's actually ramped up because of all the new materials. People are obviously not getting trained in dental school on IPS e.max, prepless veneers and lasers. Now they're hearing about it and getting excited. It's good for me because I'm getting out there more, and I enjoy that aspect of my career.

We are still doing some live patient courses. As you mentioned, you went to my esthetic courses when I was teaching at LVI. Then I formed P.A.C.~live and the Hornbrook Group, which were also live-patient, hands-on treatment courses. Now we're doing it through a series called Clinical Mastery. Doctors can go to [www.clinicalmastery.com](#) and see a list of the courses we're offering, including occlusion courses and full-mouth and anterior live patient courses, in which dentists will bring their patients and their team.

We're doing these courses primarily in Mesa, Ariz., at the new dental school [A.T. Still University](#) – Arizona School of Dentistry and Oral Health (ATSU). This is just a phenomenal dental school. It's so different from where I went to dental school. The faculty is very embracing, very technologically advanced. In fact, I was talking to the school's dean, Dr. Jack Dillenberg, and the school's recommendation for posterior restorations is composite, not amalgam. The school only teaches amalgam so its students can get through the boards. It's very interesting how different it is. The faculty is teaching veneers, implant placement, lasers. Students actually go through an entire laser curriculum. The students are learning some very cool things.

*MD: That's a real education! That's pretty impressive.*

**DH:** It's not that I'm pushing this particular school, but if a doctor who reads this has children, relatives or friends who are thinking about going to dental school, I would look at ATSU. They only have one specialty program in the school – orthodontics – which means that graduating seniors leave dental school having placed an average of 15 to 20 implants because there is no periodontal program. The students are doing perio full-mouth surgery and impacted wisdom teeth – they're just doing some really cool things.

*MD: The better part of having no specialty programs is that there are no specialists there to tell them that this stuff is too difficult for them to do, and they probably shouldn't try it. That was my dental school!*

**DH:** Exactly, same with me. So we're doing some cool things at ATSU. Again, dentists can find out more about those courses by visiting my website [www.davidhornbrook.com](http://www.davidhornbrook.com) or [www.clinicalmastery.com](http://www.clinicalmastery.com).

*MD: I want to close by telling you a story. I'm not sure if I've told you this before, but when we were together at LVI, I brought a patient ...*

**DH:** I remember the case! When you left retraction cord in there?

*MD: Whoa, whoa, whoa, I didn't leave retraction cord in there. What happened was that the two IPS Empress crowns on tooth #8 and #9 were deeply subgingival. We weren't doing much soft tissue recontouring back then, and certainly no hard tissue. But that's really what this case needed. You said, "Let's put some retraction cord in to contain the gingival fluids when we bond these crowns into place." Well, I guess I was a little sloppy. I pulled the retraction cord out from tooth #8 after curing the cement, but when I went to pull out the retraction cord on tooth #9, I had bonded it into place. I tried to get it out and you tried to get it out. The good news is that it was size 00. The bad news is that it was black, and I'd bonded it between the crown and the tooth. You could see it through the patient's thin tissue, and you said to me, "Congratulations. You are the first dentist in history to do an all ceramic crown that has a gray margin like a PFM." I've always been proud of that.*

*Later, that patient went snow skiing with his wife and she fell getting off the lift and smacked him in the face with a ski pole. And he called me in a panic and said, "My wife broke one of my front crowns off." I asked which one and he answered, "The one on the left (tooth #9)." I thought to myself, Hallelujah! Then he asked if he should look for it. "Hell no!" I didn't want to have to explain what the black string was hanging off the crown.*

*So, your course and that experience were really instrumental in teaching me to pay attention and really do things right. Dentistry has been a learning experience for me, with this average set of hands I have.*

*David, I want to thank you for being there every step of the way and being very generous with your time, especially for an interview like this.*

**DH:** Thank you, Mike! It's always great to hear your voice because I haven't talked to you in so long. You certainly have

done so much for our profession, and I consider you a mentor, a great friend, and I appreciate being asked.

*MD: That's right. And I do still maintain that you are the most well-rounded educator out there. And that's why if you're going to give your blessing to do closed-flap crown lengthening, I'll feel a lot better when I do it tomorrow, if it's one of those situations you mentioned where it is in fact indicated.*

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*Dr. David Hornbrook is a leading educator in esthetic dentistry. For information on his upcoming lectures and hands-on courses, visit [www.davidhornbrook.com](http://www.davidhornbrook.com) or [www.clinicalmastery.com](http://www.clinicalmastery.com).*

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USA

# Expertise

## Wear behavior of BruxZir®

### General Specifics

Designation:	Wear Test (Chewing Simulator)
Test Specimen:	Ŷ BruxZir Ŷ Ceramco®3
Sponsor:	Glidewell Laboratories 4141 MacArthur Blvd. Newport Beach, CA 92660 USA
Contact Person:	Wolfgang Friebauer, MDT, CDT
Date of Order:	Proposal 03/22/2010
Contractor/Investigator:	Prof. Dr. rer. nat. Dipl.-Ing. Jürgen Geis-Gerstorfer
Realization:	Ch. Schille (PhyTA)
Date of Report:	9/15/2010

**Material/Product**

The following materials were investigated:

**1.) BruxZir**

ZrO<sub>2</sub> (Tosoh Material)

Lot # S 309853 P

**2.) Ceramco®3**

Feldspathic Ceramic, A3 (Dentsply Material)

Lot # 09 001 402

**Sample Preparation**

The samples were delivered by the sponsor in a test-ready condition. Ten specimens of each material and each surface condition respectively were tested. The specimen size was ca. 10x10x2 mm.

Both groups of materials were hand prepared by the sponsor as follows:

1. Course: Diamond disk 9 µm w/300 rpm
2. Medium: Diamond disk 3 µm w/150 rpm
3. Fine: Diamond disk 1 µm w/150 rpm + Diamond polish

All samples were tested in the as delivered state.

**Test Procedure**

The wear tests were performed using a pin-on-disk apparatus (chewing simulator, Version 3.1.29, Willytech; Munich, Germany). The chewing procedure (simulation of bruxism) consisted of  $1.2 \times 10^6$  cycles under a load of 50 N and a horizontal movement of 0.2 mm (in water). As antagonists, 6 mm Steatite balls were used. This protocol simulates the clinical performance of the materials over period of approx. five years.

The amount of wear was determined topographically with the use of a 3-D profilometer (Concept 3D; Mahr, Germany) by measuring the depth of wear track of the restorative material and the height loss of the antagonist.

15 Sep 2010

# Expertise

Prof. Dr. Geis-Gerstorfer



Fig. 1: Sample in test cell with antagonist/Steatite ball holder (top).



Fig. 2: Assembled test devices in the chewing simulator.

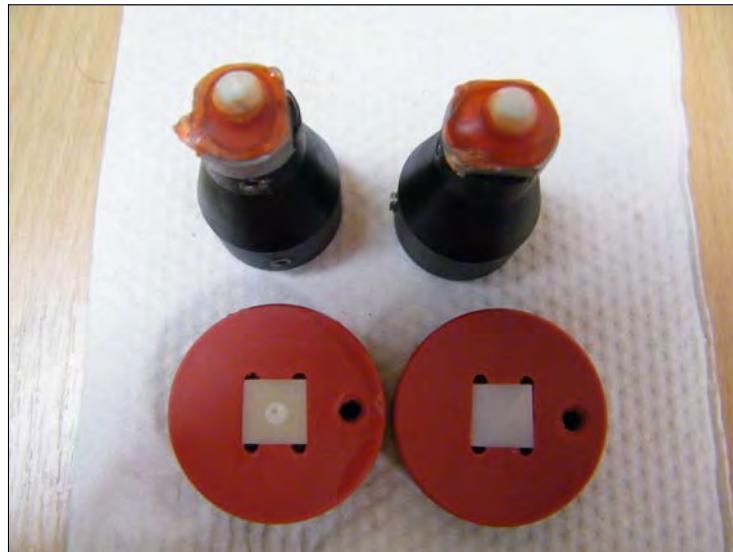


Fig. 3: Embedded Steatite balls in the antagonist holder (top), and samples after finishing the wear test (left: Ceramco®3, right: BruxZir; sample No. 10 each).

Overall three test series were performed with the chewing simulator using half of the materials at any one time (first and second run: 2x3 specimens of each material; third run: 2x4 specimens) in order to eliminate potential systematic errors during the wear tests.

To simulate moist conditions of the oral cavity, the test chambers were filled with distilled water.

As antagonists, 6 mm Steatite balls were used. The Steatite balls were polymerized in the aluminum-antagonist holders using Palavit G. A new steatite ball was applied for each test. The contact point of the antagonists was adjusted at the middle of the samples.

The cyclic two body wear tests were carried out in such a way that the antagonist hit the sample vertically with a load of 5 kg followed by a horizontal movement under a load of 0.2 mm. At the end of this track, the antagonist was lifted 5 mm and then the wear cycle was repeated at its original position 1,200,000 times. The feed-motion speed was 40 mm/min.

### Determination of wear

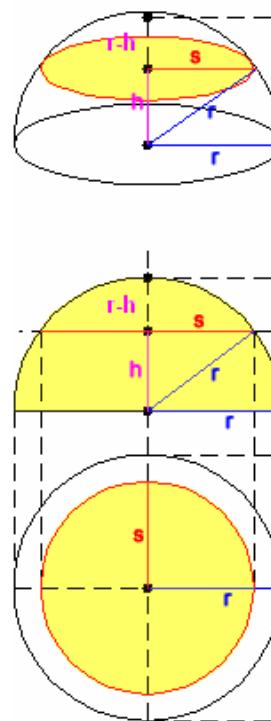
From each sample the 3-D Topography was measured before and after the wear test with 121 measuring profiles within an area of 3x3 mm using a 3-D measuring device with a 2 µm tactile probe (Apparatus: Perthometer S6P, Mahr; Goettingen, Germany; tactile probe: MFW-250; software: Perthometer Concept 3D, Vers. 7.1). This procedure was used to calculate the maximum depth of wear Pt quantitatively.

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The substance loss of the antagonist situation (Steatite balls) was determined with a calibrated stereo microscope (Wild) measuring the diameter of the flattened balls and calculating the height of wear.



**Fig. 4:** Principle of the determination of wear  $r-h$  of the balls based on the abrasion radius  $s$  measured.

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**Results**

The following tables represent the wear data of the materials investigated.

BruxZir		
Sample No.	Wear of Antagonist [µm]	Wear of Material [µm]
1	82.7	2.6
2	48.9	0.4
3	113.7	2.5
4	52.9	1.9
5	45.1	0.4
6	64.2	0.7
7	63.2	0.7
8	79.1	0.6
9	92.4	1.4
10	73.0	0.9
Mean	72	1
S.D.	21	1

Table 1: Single values of BruxZir .

Ceramco®3		
Sample No.	Wear of Antagonist [µm]	Wear of Material [µm]
1	77.5	46.9
2	81.5	91.6
3	146.2	35.0
4	110.2	50.5
5	44.1	31.7
6	194.0	82.3
7	111.2	64.1
8	158.4	Sample broken
9	122.5	31.2
10	50.6	49.2
Mittelwert	110	54
S.D.	48	22

Table 2: Single values of Ceramco®3.

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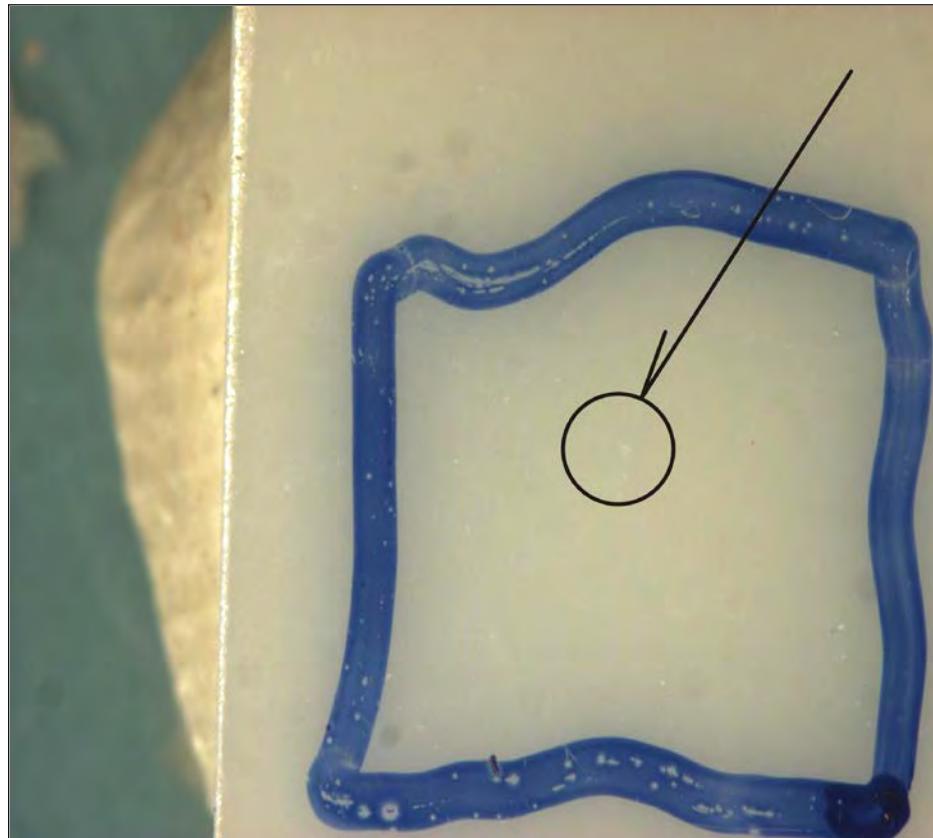


Fig. 5: BruxZir after wear test (sample No. 4). The contact area is indicated by the circle.

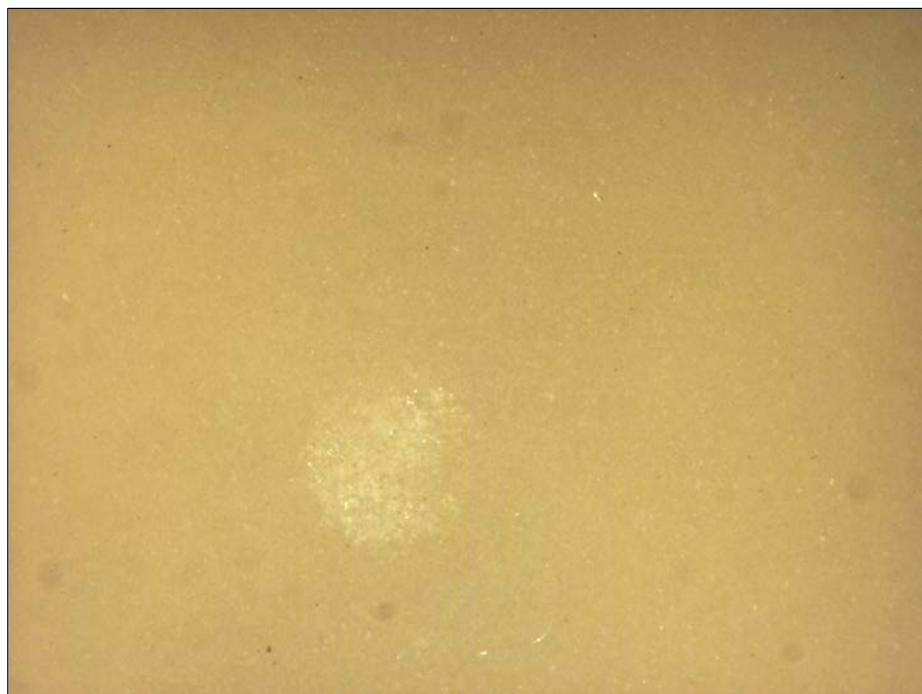


Fig. 6: Ceramco®3 after wear test (sample No. 4). The contact area is indicated by the bright spot.

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Fig. 7: Situation of the antagonist after the wear test in contact with **BruxZir** (sample No. 4).



Fig. 8: Situation of the antagonist after the wear test in contact with **Ceramco®3** (sample No. 6).

## Topography

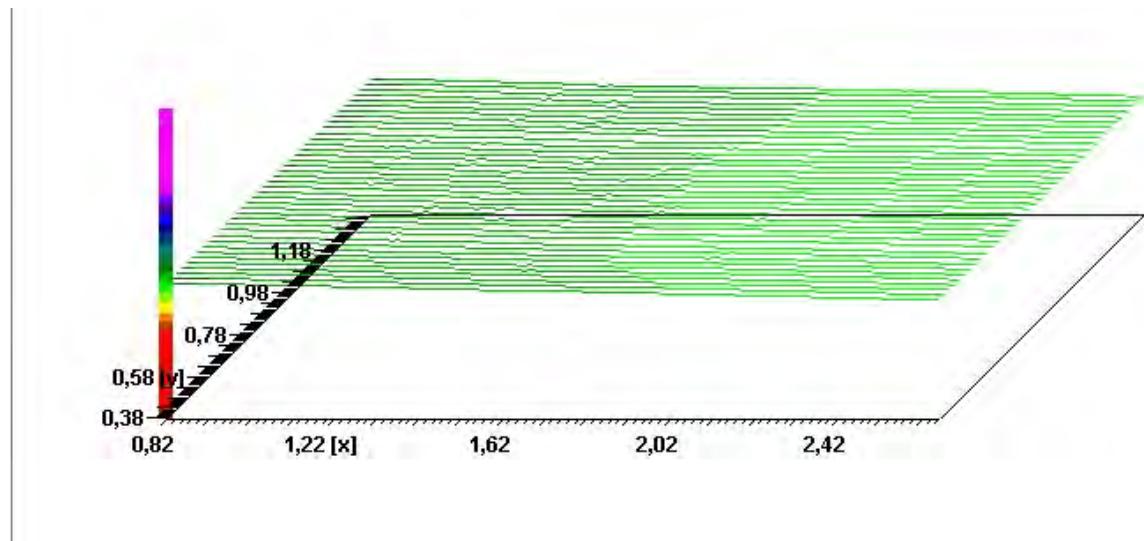


Fig. 9: Example of the topography of BruxZir after wear test (sample No. 4).

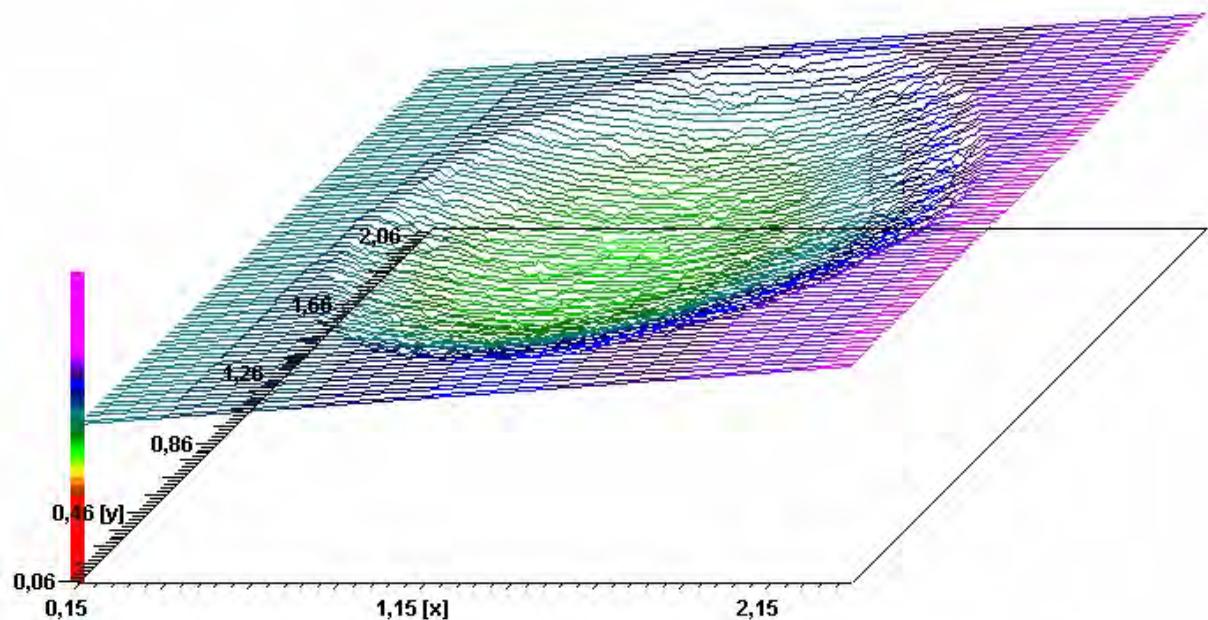


Fig. 10: Example of the topography of Ceramco®3 after wear test (sample No. 2).

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## D-Profile

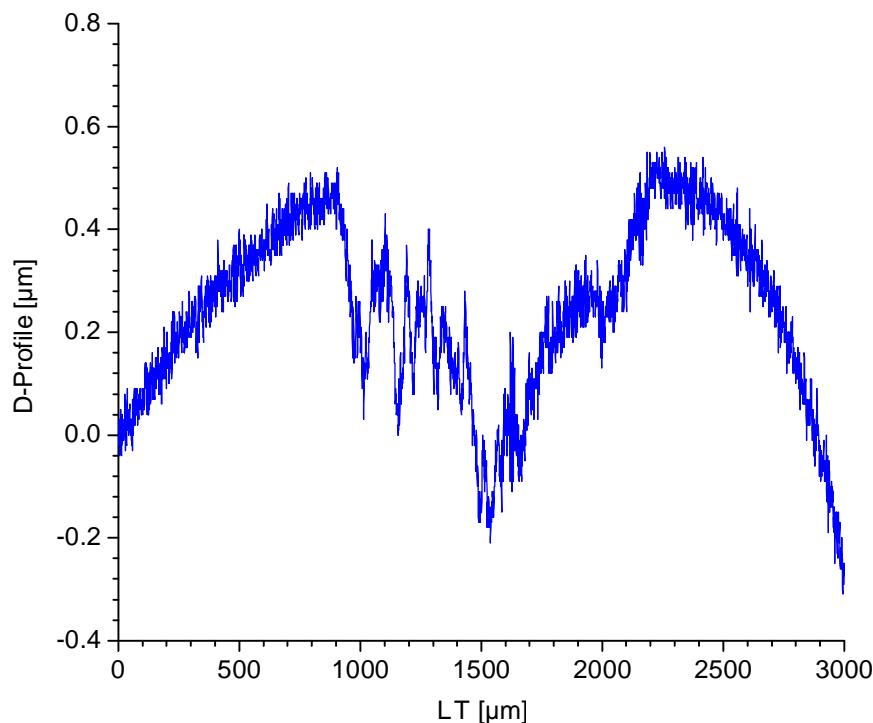


Fig. 11: Example of a single wear profile of BruxZir (sample No. 10, line 45).

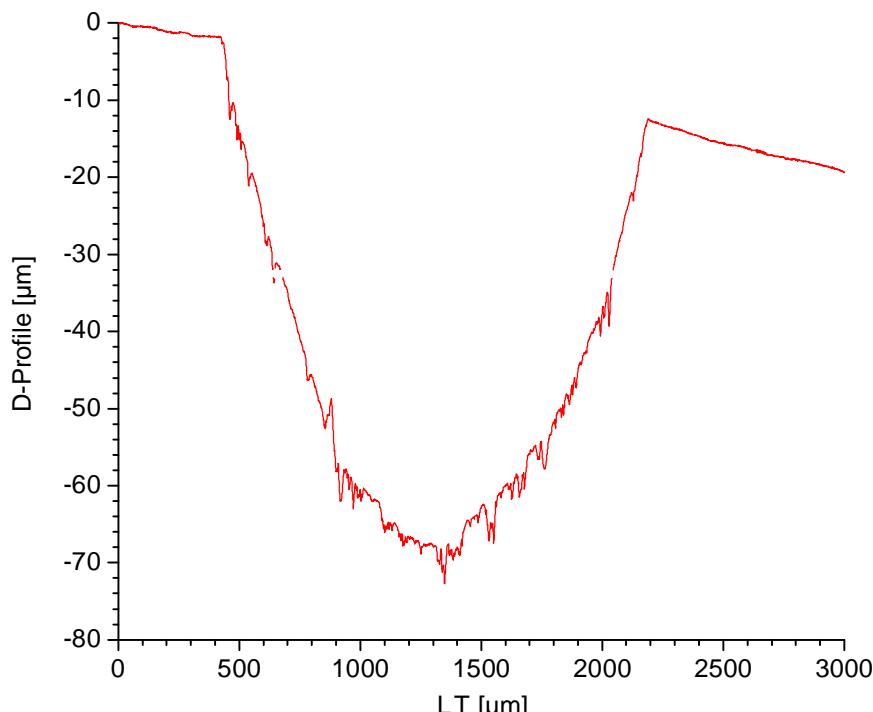


Fig. 12: Example of a single wear profile of Ceramco®3 (sample No. 2, line 45).

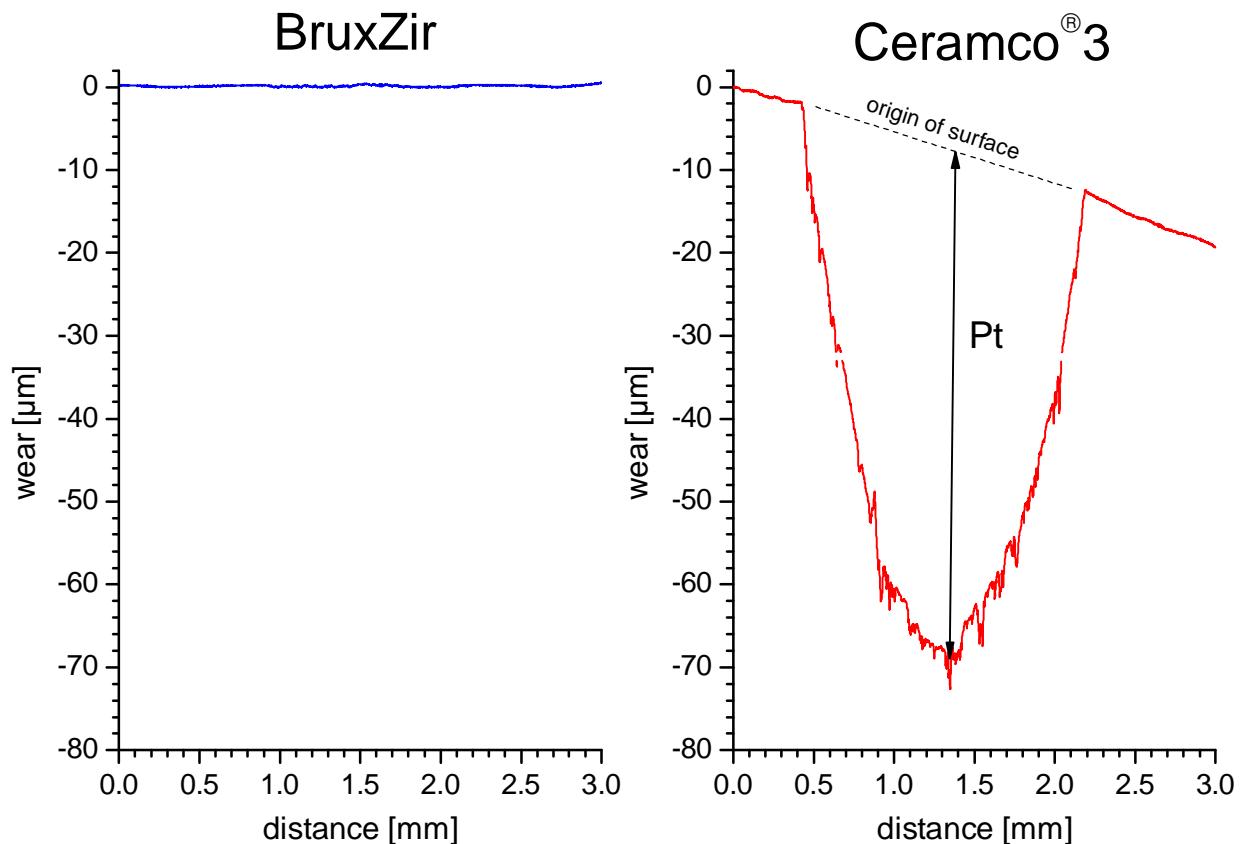


Fig. 13: Comparison of wear of BruxZir and Ceramco®3.

### Statistics

The significance Pt values of BruxZir and Ceramco 3 and the values of antagonist height loss was evaluated using t-test ( $p < 0.05$ ). The wear differences between the materials as well as between the antagonists (Steatite balls) was significantly different.

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## Summary

- Ŷ After 1.2 million wear cycles under a load of 5 kg, BruxZir revealed barely detectable wear with a measured mean value of  $1 \pm 1 \mu\text{m}$ .
- Ŷ Compared to BruxZir, wear of Ceramco®3 with a mean value of  $54 \pm 22 \mu\text{m}$  was clearly higher.
- Ŷ The wear of the antagonist situation (Steatite ball) was found to be significantly lower with BruxZir ( $72 \pm 21 \mu\text{m}$ ) than with Ceramco®3 ( $110 \pm 48 \mu\text{m}$ ).

Tübingen, 15 September 2010



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Contractor/Investigator